CHBE 560
Spring 2012
Colloid and Interfacial Phenomena
MW 1-2:15 pm Brown Hall for Mathematical Sciences 227

Course objective: This course explains the fundamental principles related to interactions, dynamics, and structure in colloidal and soft matter systems. Concepts covered include hydrodynamics, Brownian motion, diffusion, sedimentation, electrophoresis, colloidal and surface forces, polymeric forces, aggregation, deposition, and experimental methods. Modern topics related to colloids in science and technology will be discussed.

You will be able to develop theoretical description of colloids and soft matter, their physics and physical chemistry, and apply these concepts to a variety of problems involving the quantitative description of interfacial phenomena. Additional objectives involve knowledge about the characterization of properties and structure-property relationships of different types of colloidal systems, the thermodynamic and physical principles governing colloidal assembly and phase behavior.

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Office Hours: Friday 1-2:30pm

Textbook: The Colloidal Domain: Where Physics, Chemistry, Biology, and Technology Meet – Edition 2 (1999)
Authors: D. Fennell Evans, Hakan Wennerstrom
ISBN: 0471242470

Grading:
Homework: 25% of the grade (approximately 5-8 problem sets)
Project: 25% of the grade
Midterm exam: 25% of the grade
Final exam: 25% of the grade

Honor Code:
Academic dishonesty will not be tolerated. Failure to comply with the University's policy will result in a "zero" in the assignment and an "F" in the course: http://honor.rice.edu/index.cfm

Web Page:
https://owlspace-ccm.rice.edu/portal/site/CHBE-560-001-Sp12

Course Topics:

1) Describe the effect of surface forces (surface tension) on such phenomena as capillary rise and vapor pressure
2) Determine what structures result in molecules that are attracted to the interfacial regions. Be able to calculate their concentration and their effect of surface tension.
3) Describe the association phenomena of surface-active materials such as micellization and adsorption.
4) Describe the major forces between colloidal particles, both attractive and repulsive. Be able to calculate the effect of these forces on flocculation/coagulation processes.
5) Understand how to use laboratory apparatus to measure colloidal properties including surface tension, surface pressure vs. surface area relationships, particle size distribution, zeta potential and viscosity.
6) Insights into current problems of interest in colloidal phenomena.

Tentative Class Schedule (Includes Some Friday Make-Up Classes which are Highlighted and Underlined):

Jan 9th: No class
Jan 11th: No class
Jan 16th: MLK Holiday – No class
Jan 18th: Introduction to self-assembly
Jan 20th: Thermodynamic principles of self assembly I
Jan 23rd: Thermodynamic principles of self assembly II
Jan 25th: Surface tension and energy
Jan 27th: Ostwald ripening and nucleation
Jan 30th: Gibbs and Langmuir isotherms
Feb 1st: General description of electrostatic forces
Feb 6th: No class
Feb 8th: No class
Feb 13th: Poisson-Boltzman equation, ion distributions in solution,
Feb 15th: Chapman theory, Debye-Hückel approximation
Feb 20th: Electrostatic double layer forces and van der Waals force
Feb 22nd: Influence of packing and depletion forces on colloidal assembly
Feb 27th: Spring Break – No class
Feb 29th: Spring Break - No class
March 5th: Polymers as colloids: chain conformation in solution, description of energetic and entropic contributions. Charged chains: polyelectrolytes.
March 7th: Polymer association in solution
March 9th: Polymer association with surfaces
March 12th: Colloidal aggregation and flocculation
March 14th: Colloidal hydrodynamics I
March 16th: Colloidal hydrodynamics II
March 19th: Field-directed colloidal assembly I
March 21st: Field-directed colloidal assembly II
March 26th: No class
March 28th: No class
April 2nd: Colloidal manipulation with light: optical tweezers
April 4th: Colloidal Characterization I: Ultracentrifugation, diffusion measurements, viscosimetry, rotational motion, chromatography, electrophoresis
April 6th: Colloidal characterization II
April 9th: Colloidal characterization III
April 11th: New directions in colloids
April 13th: New directions in soft matter
April 16th: Class Projects
April 18th: Class Projects